ORNL/TM-6418

APORT—A Program for the Area-Based Apportionment of County Variables to Cells of a Polar Grid

David E. Fields
Craig A. Little

HEALTH AND SAFETY RESEARCH DIVISION
OAK RIDGE NATIONAL LABORATORY

OAK RIDGE NATIONAL LABORATORY
OPERATED BY UNION CARBIDE CORPORATION · FOR THE DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy $5.25; Microfiche $3.00

DISCLAIMER

ORNL/TM-6418
Distribution Category UC-11, UC-41

Contract No. W-7405-eng-26

HEALTH AND SAFETY RESEARCH DIVISION

APORT — A PROGRAM FOR THE AREA-BASED APPORTIONMENT OF COUNTY VARIABLES TO CELLS OF A POLAR GRID

David E. Fields*

and

Craig A. Little

*Computer Sciences Division

Date Published: November 1978

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

CONTENTS

LIST OF FIGURES

FIGURES

LIST OF TABLES

TABLES

ACKNOWLEDGMENTS

The authors wish to thank E. L. Etnier for kindly making available prepublication copies of her data, intermediate computations, and results. We are indebted to F. G. Goff for suggesting the basic approach to solution of the problem. We also thank P. S. Rohwer for his encouragement and support. C. J. Emerson assisted by coding the first version of the POLYVRT data manipulation code given in Appendix C. Technical reviewers were E. L. Etnier, B. D. Murphy, and M. R. Patterson.

APORT — A PROGRAM FOR THE AREA-BASED APPORTIONMENT OF COUNTY VARIABLES TO CELLS OF A POLAR GRID

David E. Fields and Craig A. Little

ABSTRACT

The APORT computer code has been developed to apportion variables tabulated for polygon-structured civil districts onto cells of a polar grid. The apportionment is based on fractional overlap between the polygon and the grid cells. Centering the origin of the polar system at a pollutant source site yields results that are very useful for assessing and interpreting the effects of airborne pollutant dissemination. The APOPLT graphics code, which uses the same data set as APORT, provides a convenient visual display of the polygon structure and the extent of the polar grid. The APORT/APOPLT methodology was verified by application to county summaries of cattle population for counties surrounding the Oyster Creek, New Jersey, nuclear power plant. These numerical results, which were obtained using approximately 2-min computer time on an IBM System 360/91 computer compare favorably to results of manual computations in both speed and accuracy.

1. INTRODUCTION

Assessment of environmental impact from a polluting facility on a human population implies a summation of numerical estimates of pollutant transport and concentration along various pathways (Rohwer and Struxness, 1972). Models of airborne pollutant transport (Moore, 1975; Culkowski and Patterson, 1976; Moore, 1976) often estimate pollutant concentration in each of several cells of a polar coordinate system centered on the source location. The cells are designated by specified radius values and by direction vectors.

Determining the human population within each polar cell has heretofore been accomplished either by manual estimation using maps overlaid by a grid or by computer methods that add a county's total population to the polar cell containing the geographic centroid of the county (Corley et al., 1977). Both of these methods are subject to error; therefore, to help alleviate both the drudgery and error of manual estimation and the error of centroid-inclusion methodology, the APORT code was developed to apportion county-based data (including human census information) into polar grid cells.

The APORT code is a numerical procedure for computing the magnitude of an extensive variable (Zemansky, 1957) appropriate to cells of a polar grid based on known magnitudes of the variables for given polygons. As used herein, an extensive variable is one that is divided as the polygon is divided; thus, a subregion containing a fraction, F, of the polygon area would contain a variable magnitude of F times the variable value of the polygon. The polygons referenced in our test application are counties, while the extensive variable is the number of beef cattle quartered in each county; however, the methodology is appropriate for many types of county-based or regional data.

The APORT methodology should provide in all cases equal or significantly greater accuracy than the sometimes-used method of ascribing the entire extensive variable of a polygon to the cell containing the polygon centroid (Corley et al., 1977). An assumption made in both the APORT methodology and the centroid-inclusion methods of Corley et al. is that the extensive variable (beef cattle in this case) is homogeneously distributed throughout the polygon (county). Errors may be introduced into APORT estimates by high-density regions of the extensive variables (e.g., cattle feed lots, and major cities). However, the average error for those using the APORT method should always be smaller than that induced by using the centroid-inclusion methodology.

This report also discusses the APOPLT code, which uses the same data set as APORT and plots the county polygons and corresponding FIPS (Federal Information Processing Standards) identification numbers. The APOPLT code also superimposes a set of concentric circles corresponding to radii of the polar coordinate system with origin at the pollutant source site.

2. APORT COMPUTER CODE STRUCTURE

The subprogram structure of the APORT code is diagrammed in Fig. 1. The APORT code consists of the main program and seven subprograms. The calling order of the subprograms is from top to bottom in this figure. Job control language for APORT is included as Appendix A, while a code listing constitutes Appendix B.

The main program accepts input data pertaining to two separate coordinate systems: the first is the SYMAP system (Dougenik and Sheehan, 1975) in which coordinates are expressed in map inches to the right of and above an origin, while the second coordinate system is a cylindrical polar grid with origin normally fixed at the site of the pollutant source. Distances in the polar system are expressed in miles. The main program first reads the origins of the two coordinate systems and the scale factor for the SYMAP system. The main program also computes scale factors and offset magnitudes for transformations between the two coordinate systems. Included too in the main program are most of the program logic governing flow of control, most of the program output statements, and calls to all subprograms. Subroutine SENSE is, in addition, called by one other subprogram.

Subroutine PLYCOR reads map coordinates in the SYMAP coordinate system, separates them into coordinate pairs corresponding to individual polygon vertices in the polar system, and stores each set of coordinate pairs in vectors XP and YP. It also provides the number of coordinate pairs (the number of vertices) to the main program. The coordinate pairs furnished to the main program have been translated and scaled to correspond to the polar coordinate system.

Subroutine PLYCEN computes the coordinates of polygon centroids and returns these coordinates, in the polar system to the main program.

Subroutine CELCEN uses the sector and radial bounds of grid cells of the polar system to compute the coordinates of centroids and returns these to the main program.

Logical function FAR returns a value "TRUE" to the main program if the polar cell and the polygon centroids are sufficiently separated so that cell-polygon interaction is impossible. It is the responsibility of the user to choose a test value, FARAWY, expressed in miles, beyond which this overlap is impossible. The value of FARAWY has been set in the main program to 100 miles. If a "FALSE" condition is returned to the main program, then overlap of the cell and polygon is considered possible and succeeding subroutines will be called.

Subroutine CELCOR computes the vertex coordinates of polar grid cells. These are returned to the main program.

Subroutine IUCALC (Edwards and Coleman, 1976) computes coordinates of vertices of the intersection polygons. These intersection polygons consist of area common to both polygons and polar cells.

Logical function SENSE (Edwards and Coleman, 1976) computes the area of a polygon and its sense of closure. This function is called by the main program and by subroutine IUCALC.

For the test case described in this report, the APORT code required 56K of core and 3 seconds in the GO step on an IBM system 360/91 computer. The SUBSET data set operation code discussed in Chap. 2 required 168K of core and ran in 2 minutes, while the APOPLT plotting code described in Chap. 6 required 154K and 2 seconds on the same computer system. In these runs and in the Appendices, the APORT and APOPLT programs were dimensioned to work with up to 50 polygons, each having as many as 25 vertices.

3. PREPARATION OF CODE INPUT

The APORT procedure works equally well with any polygon set. The application here considers county data. Polygon (county) vertex coordinates are taken from a data base written in DIME (Dual Independent Map Encoding) format using the POLYVRT program (Dutton, 1974). The DIME data base is available from the distributors of POLYVRT or in reformated form from its original compiler.* County DIME files for the United States are stored on one reel of tape, and counties of interest are selected by specifying state and county FIPS codes.

Data set preparation is summarized in Fig. 2. Program SUBSET, included in Appendix C, uses POLYVRT to select a subset of the DIME data base. The APORT user should refer to POLYVRT documentation for instructions for modifying SUBSET. The code in Appendix C writes onto temporary disc storage (file T.DEF16829. POLY) the vertex coordinates that constitute most of the APORT input data set. The reader may choose to punch this file onto cards or, as was done by the authors, transfer it to a PDP-10 computer system for editing and future use.

Vertex coordinates are printed in SYMAP format, using the SYMAP output option of POLYVRT. The suboption of using a nonzero value in the fourth numeric field of the "G-OUTPUT SYMAP" card ensures that the X value will be put before the Y value (contrary to standard SYMAP format) and that the Y scaling is identical to the X scaling (Christmon, 1978). This suboption is not discussed in POLYVRT documentation.

*Magnetic tapes of county and metropolitan DIME files may be obtained from the User Service Staff, Bureau of the Census, Washington, DC.

The APORT input data set structure is given in Table 1. This data set, used also with the APOPLT code (Chap. 6), includes vertex coordinates in SYMAP format, specifications of latitude and longitude of the origin in SYMAP system, and latitude and longitude of the origin of the polar system. The latter is usually the pollutant source position. Also specified in the input data set is the scale factor, the ratio of ground truth inches to one SYMAP inch, that was specified before in the SUBSET code. This factor is also printed in the SUBSET line printer output. Finally, the input data set holds a unique numeric code for each polygon (the FIPS code for each county) and the value of the extensive variable (e.g., number of beef cattle) for each polygon. Appendix D consists of a sample data set for use with the APORT and APOPLT codes.

4. INTERPRETATION OF OUTPUT

Appendix E contains APORT output corresponding to the input data set of Appendix D. Output variables are defined in Table 2. The first two lines of output contain information entered on the first two cards of input which specify geographical coordinates of the origin of the two grid systems (rectangular SYMAP and polar) and the scale factor of the former. Following are the numeric (FIPS) codes and values of extensive variables for the polygons (counties) of interest. If the number of polygons referenced here exceeds the number for which the code was dimensioned, the message "NUMBER OF POLYGONS SPECIFIED EXCEEDS LIMIT OF 50" will be printed. This maximum dimension may be changed by altering the space allocated to vectors VARP and NFIPS in the main program.

The quantities XOFSET and YOFSET next printed are computed in the APORT main program and represent the X and Y offsets, in miles, of the origin of the polygon (county) coordinate system with respect to the origin of the polar grid used for plotting. The quantity ALAT printed here is the average latitude (expressed in radians) of the two origins.

The next section of output details computation of the "intersection polygons" from the overlap of counties and cells of the polar grid and the determination of the value of the extensive variable for each cell. The name of the contribution of a polygon to a cell is VARCEL. The message "ERROR; NORC" will be printed if the IUCALC subroutine has attempted to use more scratch storage than available in array WORK. This array has been dimensioned 100 in the main program (Edwards and Coleman, 1976). If this message is printed, the dimension of WORK and the value of parameter WRKMAX should be increased in the main program to greater than 100. These values should be identical. The message "PRE-MATURE END OF COORD DATA IN SUB PLYCOR" will be printed either if the number of polygons described in the input data exceeds the number NPOLY specified on card 1 of the input data set or if the data set is not properly terminated with the final card having "9999" in the first four columns. Upon proper data input, this section of output is terminated by the message "END OF POLYGON COORD SPECIFICATION".

A summary of results is printed last. The summary is titled "SUMMARY OF EXTENSIVE VARIABLE MAGNITUDES; CELL RADIUS (COLUMN) BY CELL SECTOR (ROW)." These values are the sums for each polar cell of the VARCEL values printed previously.

5. APPLICATION OF THE APORT CODE TO DATA FOR THE OYSTER CREEK, NEW JERSEY, NUCLEAR REACTOR SITE

The environmental impact of the Oyster Creek, New Jersey, Nuclear reactor has been considered recently (Etnier, 1978a). Much of the needed data had been compiled on a per-county basis, and it was necessary to recompile the data on a polar basis to make it compatible with air-transport simulation models. This recompilation was done manually for the relevant extensive variables, including beef cattle and calves, milk cows, vegetable crops, and human population (Etnier, 1978a). County-based variable magnitudes were apportioned to cells on a polar grid based on the areal overlap between county and cells. The grid used was defined by 16 sectors, with the center of the first to the north with sector numbers increasing counterclockwise, and by 5 annuli bounded by circles of radii 10 through 50 miles in integral multiples of 10 miles. As a test case, we have used the APORT code to compute the number of beef cattle per (polar) cell for the same 50-mile-radius region about the reactor site as was used above. Thus, these cells correspond to the interstices of the grid defined above.

Table 3 lists the number of beef cattle per county and the corresponding county FIPS code for the counties intersecting the study region. These data comprise a portion of the sample input data set in Appendix D.

Table 4 compares APORT results with those obtained by manual methods (Etnier, 1978a) for cells of all 16 sectors. Both methods apportion county data based on areal overlap; that is, if a fraction, F, of the area of a county overlaps a particular cell, then the fraction of the variable of magnitude Y for that county lying in the cell is F times Y.

The correlation between the first APORT estimates of beef cattle in a cell and the manual estimates was 0.97. Although a paired t-test indicated no significant difference ($p > .05$), close inspection of Table 4 indicated that the first APORT estimate was somewhat lower than the manual estimate for most cells.

Visual inspection and comparison of the manual map (Etnier, 1978a) with an APOPLT output map and overlay suggested reasons for this small discrepancy. The origin of the concurrent circles as located by the manual method appeared to be some distance further inland than the APOPLT output origin. The westernmost arc of the 50-mile radius as drawn manually seemed to be about 4 miles too far west when compared to an APOPLT map. The combination of different origin locations and manual limitations of drawn radii could probably account for a higher estimate of cattle populations in each cell by the manual method.

As an easy assessment of the impact created by incorrectly locating the radii origin, we arbitrarily moved the input location of the radii center 2 miles to the west. The second group of APORT estimates (Table 4) achieved roughly the same coefficient of correlation (0.973) of beef cattle populations for each cell with the manual method. The correlation coefficient between the two APORT runs was 0.990. Thus, even with an intentional 2-mile displacement, the two APORT-generated sets of results differed little. Some minor mathematical errors were detected in the intermediate computations used in the manual method (Etnier, 1978b). Also, there were small differences between the maps used for the manual computation and the polygon-structured data base used in the APORT approach; these were particularly noticeable near the land-ocean boundary.

It is also generally accepted (Christmon, 1978) that the county polygon data set contains systematic errors that accrue, to as much as 5% in area in moving from the southwest to the northeast of the United States. We would expect, then, that APORT results would be most accurate in the southwest United States. Finally, it was assumed in the manual method that no cattle were quartered within 5 miles of the polar origin (source site). This assumption is probably responsible for most of the remaining discrepancy.

We conclude that, whereas both the computer and the manual approaches yield acceptable results, the APORT method is preferable when reproducibility and convenience are desired.

6. USE OF APOPLT PLOTTING CODE

Code APOPLT may be used to plot the polygons specified in the APORT data set. Figure 3 is plotted output from code APOPLT corresponding to the polygons considered in this report. Such a plot is useful to ensure that data have been entered properly and to develop a geographic perspective of the area being studied. Superimposed over the polygons is a set of concentric circles of radii which define cells of the polar system which are specified in the main program to be integral multiples of 10 miles, up to 50 miles. The same data set is used for APOPLT and for APORT. A legend showing the map distances corresponding to 20 miles is also shown.

The source listing of code APOPLT included in Appendix G contains the APORT main program and subroutine PLT1; the main program also calls several subroutines that are part of the DISSPLA* package. This software must be resident on the user's system if APOPLT is to execute properly. The reader may refer to DISSPLA documentation (Hirschsohn, 1971 a,b).

7. SUMMARY

The APORT computer code generates a polar-grid population pattern based on fractional overlap between polygon-structured civil districts and cells of the polar grid. Centering the origin of the polar system at a pollutant source site yields results that are very useful for assessing and interpreting the effects of airborne pollutant dissemination. The APORT/APOPLT methodology is useful for any type of data that is filed by geographical region.

The APOPLT graphics code, which uses the same data set as APORT, provides a convenient visual display of the polygon structure and the extent of the polar grid.

Application of the APORT/APOPLT methodology to county summaries of cattle populations as described herein has verified the validity of the approach. This computer method compares favorably to manual computations in both speed and accuracy.

---

*Proprietary software product of Integrated Software Systems Corp., San Diego, California.

REFERENCES

Christmon, N., 1978, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University, private communication.

Corley, J. P., et al., 1977, "An Improved Method for the Calculation of Population Doses from Nuclear Complexes over Large Geographical Areas," presented at the annual meeting of the Health Physics Society, Atlanta, Georgia.

Culkowski, W. M. and M. R. Patterson, 1976, *A Comprehensive Atmosphere Transport and Diffusion Model*, Oak Ridge National Laboratory Report, ORNL/NSF/EATC-17.

Dougenik, J. A. and D. E. Sheehan, 1975, *SYMAP User's Reference Manual*, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University.

Dutton, Geoffrey, et al., 1976, *POLYVRT — A Program to Convert Geographic Base Files, Version 1.1*, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University.

Edwards, R. G. and P. R. Coleman, 1976, *IUCALC — A FORTRAN Subroutine for Calculating Polygon-Line Intersections, and Polygon-Polygon Intersections, Unions, and Relative Differences*, Oak Ridge National Laboratory Report, ORNL/CSD/TM-12.

Etnier, E. L., 1978a, *An Application of the CUEX Methodology to the Combined Radiological Effect of Aquatic and Atmospheric Releases from a Nuclear Facility*, ORNL Report in preparation.

Etnier, E. L., 1978b, private communication.

Hirschsohn, I., 1970a, *Display Integrated Software System and Plotting Language I*, Integrated Software Systems Corporation.

Hirschsohn, I., 1970b, *Display Integrated Software System and Plotting Language II*, Integrated Software Systems Corporation.

Moore, R. E., 1975, *AIRDOS — A Computer Code for Estimating Population and Individual Doses Resulting from Atmospheric Releases of Radionuclides from Nuclear Facilities*, Oak Ridge National Laboratory Report, ORNL/TM-4687.

Moore, R. E., 1977, *The AIRDOS — II Computer Code for Estimating Radiation Dose to Man from Airborne Radionuclides in Areas Surrounding Nuclear Facilities*, Oak Ridge National Laboratory Report, ORNL-5245.

Rohwer, P. S. and E. G. Struxness, 1972, "Environmental Indices for Radioactivity Releases," pp. 249-55 in *Indicators of Environmental Quality*, ed. by W. A. Thomas, Plenum Press, New York.

Zemansky, M. W., 1957, *Heat and Thermodynamics*, McGraw-Hill, New York.

ORNL-DWG 78-18088

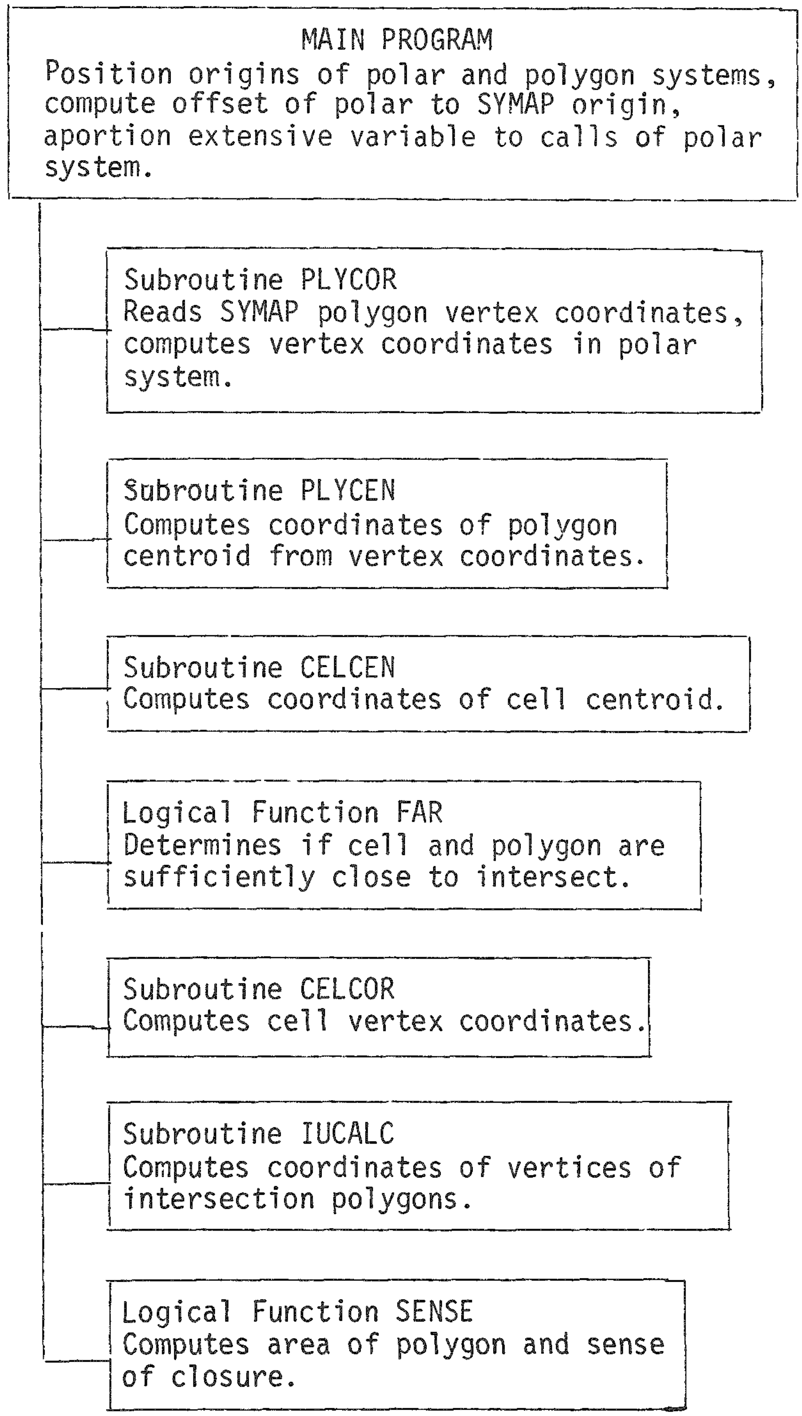

Fig. 1. Subprogram structure of code APORT.

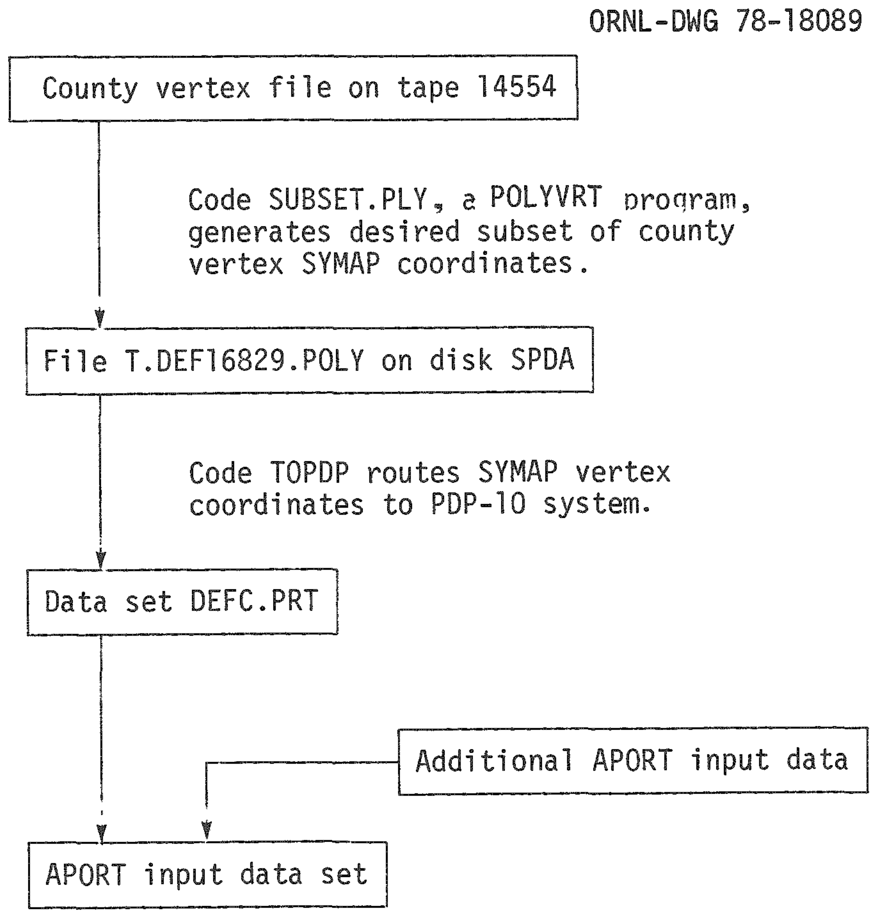

Fig. 2. Preparation of county-base APORT data set.

ORNL-DWG. 78-14917

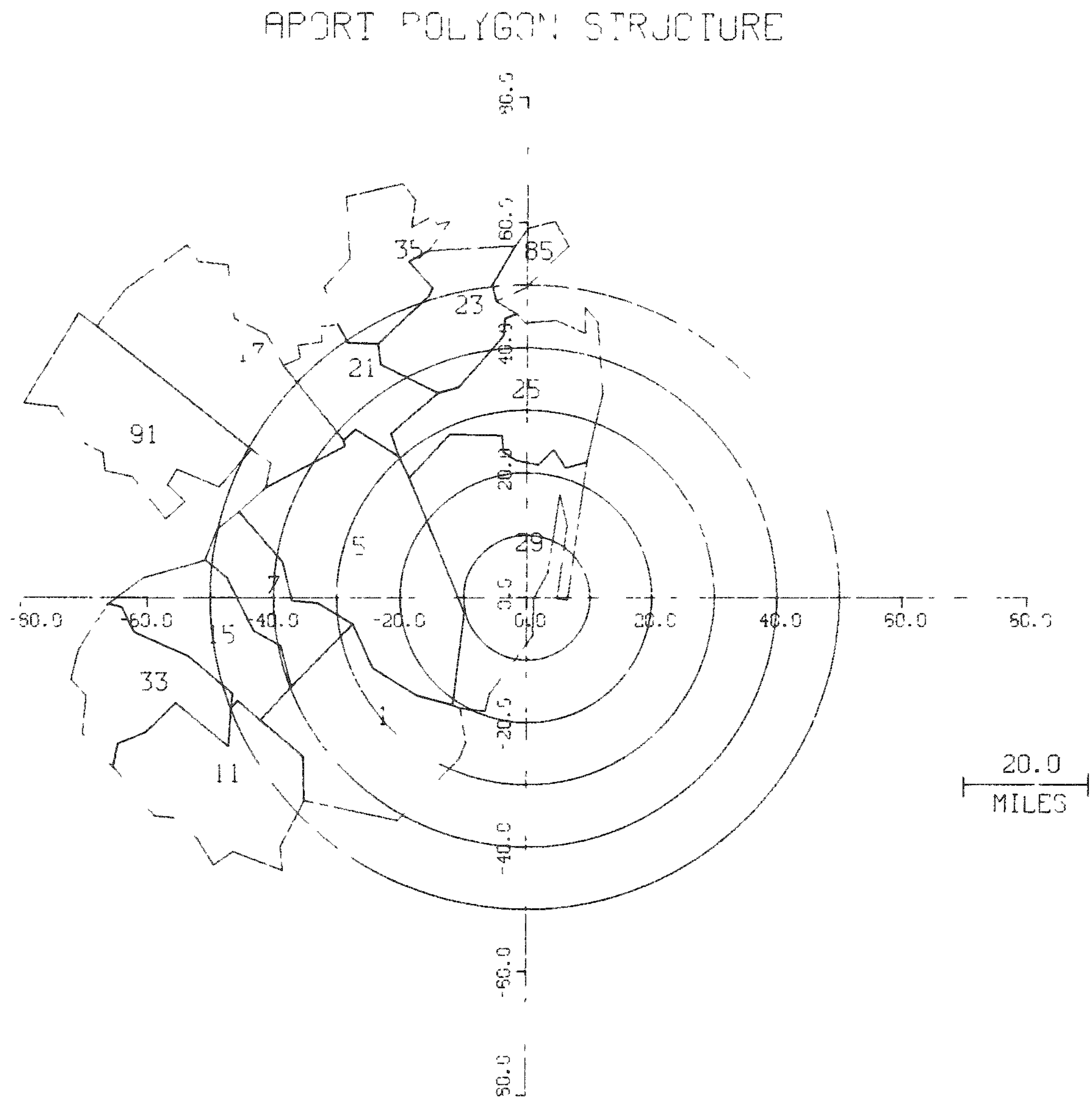

Fig. 3. County polygons plotted using APOPLT code. Polygons shown here are counties, and the numerical identifiers are FIPS codes. The right boundary of the polygon group is the Atlantic Ocean.

Table 1. Structure of input data set

Card number	Columns	Format, variable name and definition, comments	
1		(1X, 3F10.2, I5)	
			This card specifies the SYMAP system.
	2 - 11	XORPLY	Longitude of SYMAP origin.
	12 - 21	YORPLY	Latitude of SYMAP origin
	22 - 31	SCALE	Number of ground-truth inches per SYMAP system unit (inch). This must be the same as that specified in the SUBSET code (included as Appendix C) labeled FRACTION in the E-MANIPULATE package (Dutton 1974).
	32 - 36	NPOLY	Number of (county) polygons.
2		(1X, 2F10.4)	
			This card specifies the polar coordinate system.
	2 - 11	XORCEL	Longitude of polar origin.
	12 - 21	YORCEL	Latitude of polar origin.
3		(I3, I5)	
			Specifies first polygon nongeographic data.
	2 - 3	NFIPS(1)	Two digit polygon code for first polygon. Here this is the county FIPS code.
	4 - 8	VARP(1)	Magnitude of extensive variable for first polygon.
4 through NPOLY+2			Include same type of information as card 3.
NPOLY+2		(I3, I5)	Specifies last polygon non-geographic data. The number of polygons must be less than or equal to 50.
	1 - 3	NFIPS (NPOLY)	Two-digit polygon code for last polygon.

Table 1. Structure of input data set (cont.)

Card number	Columns	Format, variable name and definition, comments	
NPOLY+3		(I4, 4X, A1, 2F10.4, 40X, I7, I3)	
			This and subsequent cards are read by subroutine PLYCOR.
	1 - 4	IEND	Value equals zero or blank for all cards except last card. For last card, value equals 9999, with subsequent numeric fields bland.
	9	START	Value equals A for first card of the set of XPV, YPV coordinate pairs for each polygon, or value equals another character for other cards.
	10 - 19	XPV	X value, in SYMAP units, of first vertex of first polygon.
	20 - 29	YPV	Y value, in SYMAP units, of first vertex of first polygon.
	70 - 76	IF	Five-digit polygon identifier code. The first two digits are normally the state FIPS code and the last three are the county code.
	77 - 79	NP	Vertex number, equals 1 for first card of each polygon set.
			Except for the last card, the remaining cards are vertex coordinate sets for each polygon. Within each set are cards specifying positions of vertices of each polygon.
Final		(I4, 4X, A1, 2F10.4, 40X, I7, I3)	
	1 - 4	IEND	Value equals 9999.

Table 2. Output variables describing each intersection polygon

Variable	Definition and comments
J	Number of intersection polygons found in each polygon-cell overlap. This number will rarely be greater than one. Separate overlap information is printed for each intersection polygon.
IPOL	Ordinal number of county polygon in input data set.
NFIPS	FIPS (Federal Information Processing Standard) code for county polygon.
SECTOR	Sector number of polar grid. Sixteen sectors exist, numbered counterclockwise from the north.
RADIUS	Annulus number of polar grid. The first annulus goes from 0 to 10 miles, the second from 10 to 20 miles, etc.
AREAL OVERLAP	Area of overlap (area of intersection polygon square miles).
AREAP	Area of county polygon (square miles).
AREACL	Area of cell of polar grid (square miles).
VARCEL	Contribution of extensive variable from county polygon to cell. Expressed in same units as used for the extensive variable in input data deck (Chap. 3).

Table 3. Number of beef cattle in counties intersecting region of interest from 1967 Agricultural Census

County	State	County FIPS code	Number of cattle
Atlantic	NJ	1	131
Burlington	NJ	5	13,078
Camden	NJ	7	125
Cumberland	NJ	11	3,760
Gloucester	NJ	15	3,816
Mercer	NJ	21	3,754
Middlesex	NJ	23	2,753
Monmouth	NJ	25	4,028
Ocean	NJ	29	349
Salem	NJ	33	17,125
Somerset	NJ	35	7,198
Richmond	NY	85	0
Bucks	PA	17	18,834
Montgomery	PA	91	15,122

Table 4. Number of beef cattle in cell sectors by manual[a] and computer methods

Sector	Annulus radius (miles)	Manual method[b]	APORT code	APORT code: polar center displaced 2 miles west
1 (N)	0 - 10	9	10	10
	10 - 20	38	30	30
	20 - 30	735	641	577
	30 - 40	1318	1090	1096
	40 - 50	1195	1202	1495
2 (NNW)	0 - 10	9	10	10
	10 - 20	38	30	30
	20 - 30	473	304	364
	30 - 40	1509	1257	1382
	40 - 50	2707	1807	2155
3 (NW)	0 - 10	9	10	10
	10 - 20	87	72	213
	20 - 30	872	909	1179
	30 - 40	2935	2222	2447
	40 - 50	3901	3710	3928
4 (WNW)	0 - 10	9	10	16
	10 - 20	664	637	830
	20 - 30	1569	1520	1520
	30 - 40	2657	2165	2209
	40 - 50	3453	2501	2218
5 (W)	0 - 10	7	12	92
	10 - 20	915	879	912
	20 - 30	1574	1466	1396
	30 - 40	1092	1131	880
	40 - 50	959	821	1029
6 (WSW)	0 - 10	7	18	118
	10 - 20	1046	907	925
	20 - 30	922	969	707
	30 - 40	423	78	255
	40 - 50	1462	2222	2046

Table 4. Number of beef cattle in cell sectors by manual[a] and computer methods (continued)

Sector	Annulus radius (miles)	Manual method[a]	APORT code	APORT code: polar center displaced 2 miles west
7 (SW)	0 - 10	9	10	26
	10 - 20	916	591	830
	20 - 30	279	568	364
	30 - 40	34	45	31
	40 - 50	527	319	477
8 (SSW)	0 - 10	9	10	10
	10 - 20	286	31	141
	20 - 30	7	33	49
	30 - 40	16	13	17
	40 - 50	29	3	3
9 (S)	0 - 10	9	9	10
	10 - 20	5	2	7
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
10 (SSE)	0 - 10	5	3	7
	10 - 20	0	0	0
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
11 (SE)	0 - 10	0	1	3
	10 - 20	0	0	0
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
12 (ESE)	0 - 10	0	1	2
	10 - 20	0	0	0
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0

Table 4. Number of beef cattle in cell sectors by manual[a] and computer methods (continued)

Sector	Annulus radius (miles)	Manual method[b]	APORT code	APORT code: polar center displaced 2 miles west
13 (E)	0 - 10	0	3	5
	10 - 20	0	0	0
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
14 (ENE)	0 - 10	0	5	6
	10 - 20	0	0	3
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
15 (NE)	0 - 10	3	6	9
	10 - 20	0	6	11
	20 - 30	0	0	0
	30 - 40	0	0	0
	40 - 50	0	0	0
16 (NNE)	0 - 10	7	10	10
	10 - 20	21	25	30
	20 - 30	329	388	484
	30 - 40	443	494	659
	40 - 50	28	293	390

[a]Etnier, 1978a.

[b]Manual method assumed no cattle in the 0-5 miles annuli.

APPENDIX A

JOB CONTROL LANGUAGE FOR EXECUTION OF APORT CODE ON IBM SYSTEM 360/91 COMPUTER

The use of "=" in this appendix may indicate the insertion of the following data set or subroutine; for example, "= APORT" indicates that the file denoted by APORT is to be inserted here.

```
//DEFAPOR JOB (00000 ),'XCSD-FIELDS-R212',MSGLEVEL=1
//*CLASS CPU91=25S,IO=2
/*ROUTE  PRINT LOCAL
/*ROUTE  PUNCH LOCAL
// EXEC FORTHCLG,
// PARM.FORT='OPT=2,XREF',REGION.FORT=270K,
// PARM.GO='EU=-1,DUMP=I',REGION.GO=80K
//FORT.SYSIN DD *
=DEFS.PCH
//LKED.DEF DD DSN=ONLINEA.RGEHE744.IUCALCHX,
//  DISP=SHR
//LKED.SYSIN DD *
 INCLUDE DEF
//GO.SYSPRINT DD SYSOUT=A
//GO.FT05F001 DD *
=APORT.DAT
//
```

APPENDIX B

FORTRAN IV SOURCE LISTING OF APORT CODE.

```
C        MAIN PROGRAM APORT
C
C        AUTOMATED REGIONAL METHODOLOGY CODE
C        APPORTIONS EXTENSIVE VARIABLE TO CELLS OF POLAR GRID SYSTEM
C        D.E.FIELDS AND C.A.LITTLE
C
      DIMENSION RADIUS(5),XCL(4),YCL(4),XP(25),YP(25),WORK(100),
     1RCX(60),RCY(60),X(8),Y(8),INORC(2,10),NFIPS(50)
      DIMENSION VARSUM(5,16)
      COMMON AREA
      INTEGER WRKMAX,VARP(50)
      LOGICAL FAR
      DATA WRKMAX/100/,FARAWY/100./,START/999./,ASTART/'A'/
      DATA NP/100/,VARSUM/80*0.0/
C        READ ORIGIN OF SYMAP COORDINATE SYSTEM
C         IN DEGREES LAT AND LON
C        READ SCALE FACTOR, INCHES TO INCHES:    SCALE
      READ(5,8000)XORPLY,YORPLY,SCALE,NPOLY
 8000 FORMAT(1X,2F10.4,F10.2,I5)
      WRITE(6,8000)XORPLY,YORPLY,SCALE,NPOLY
      SCALE=SCALE/5280./12.
      IF(NPOLY.GT.50)WRITE(6,8005)
 8005 FORMAT(2X,'NUMBER OF POLYGONS SPECIFIED EXCEEDS LIMIT OF 50')
C        READ ORIGIN OF POLAR COORDINATE SYSTEM
C         IN DEGREES LAT AND LON
      READ(5,8010)XORCEL,YORCEL
 8010 FORMAT(1X,2F10.4)
      WRITE(6,8010)XORCEL,YORCEL
C        READ VALUE OF EXTENSIVE VARIABLE FOR EACH POLYGON
      READ(5,8015)(NFIPS(I),VARP(I),I=1,NPOLY)
 8015 FORMAT(I3,I5)
      WRITE(6,8020)(NFIPS(I),VARP(I),I=1,NPOLY)
 8020 FORMAT(1X,I3,I5)
C        COMPUTE OFFSET, IN MILES, OF POLYGON IN POLAR SYSTEM
      ALAT=(YORPLY+YORCEL)/360.*3.141593
      XOFSET=(-XORPLY+XORCEL)*60.*1.1516*COS(ALAT)
      YOFSET=(YORPLY-YORCEL)*60.*1.1516
      WRITE(6,8025)XOFSET,YOFSET,ALAT
 8025 FORMAT(2X,'XOFSET,YOFSET,ALAT=',3F15.6)
C        POLYGON LOOP
C        RADIAL DISTANCES IN MILES
      DO 100 I=1,5
  100 RADIUS(I)=10.*FLOAT(I)
      DO 120 IPOL=1,NPOLY
C        DETERMNE POLYGON COORDINATES AND NUMBER OF VERTICES
      CALL PLYCOR(XP,YP,NP,SCALE,XPV,YPV,ASTART,START,XOFSET,YOFSET)
C        DETERMINE PLOYGON CENTROID AND POLYGON EXTENSIVE VARIABLE
      CALL PLYCEN(XP,YP,XPCEN,YPCEN,NP)
C
C        DELETE REPEATED REFERENCES TO FIRST POLYGON VERTEX
      NP=NP-1
C
C
C        BEGIN SEARCH AND INTERSECTION PROCEDURE
C
C        SECTOR LOOP
      DO 115 ICLSEC=1,16
C        RADIUS LOOP
      DO 115 ICLRA=1,5
C        COMPUTE CELL CENTROID
      CALL CELCEN(ICLSEC,ICLRA,RADIUS,XCLCEN,YCLCEN)
C        ARE CELL AND PLOYGON FAR APART?
      IF(FAR(XPCEN,YPCEN,XCLCEN,YCLCEN,FARAWY))GOTO115
```

```
C
C
C       POLYGON AND CELL MAY OVERLAP
C
C       DETERMINE CELL COORDINATES
      CALL CELCOR(ICLSEC,ICLRA,RADIUS,XCL,YCL,NCL)
C       DETERMINE INTERSECTION OF POLYGON AND CELL; COMPUTE AREAS
      CALL IUCALC(XP,YP,NP,XCL,YCL,NCL,2,WORK,WRKMAX,NORC,INORC,RCX,RCY)
C       CHECK FOR SMALL DIMENSION OF ARRAY WORK
      IF(NORC.LT.0)WRITE(6,8030)NORC
 8030 FORMAT(2X,'ERROR; NORC =',I6)
      IF(NORC.LE.0)GOTO115
      OVRLAP=0.0
C       DETERMINE POLYGON AND CELL AREAS
      CALL SENSE(XP,YP,NP)
      AREAP=AREA
      CALL SENSE(XCL,YCL,NCL)
      AREACL=AREA
      DO110 J=1,NORC
      WRITE(6,8035)J,IPOL,NFIPS(IPOL)
 8035 FORMAT(2X,'POLYGON INTERSECTION, J=',I5,' AND IPOL =',I5         ,
     1': NFIPS = ',I3)
      KLIMIT=INORC(2,J)
      DO105 K=1,KLIMIT
      X(K)=RCX(K+INORC(1,J))
      Y(K)=RCY(K+INORC(1,J))
  105 CONTINUE
C       WRITE(6,50)(X(K),Y(K),K=1,KLIMIT)
 8040 FORMAT(2X,2F12.5)
C       DETERMINE AREA OF INTERSECTION POLYGONS
      CALL SENSE(X,Y,KLIMIT)
C       COMPUTE TOTAL OVERLAP AREA
      OVRLAP=OVRLAP+AREA
  110 CONTINUE
      VARCEL=VARP(IPOL)*OVRLAP/AREAP
      WRITE(6,8045)
 8045 FORMAT(T5,'SECTOR',T15,'RADIUS',T25,'AREAL OVERLAP',             T
     140,'  AREAP  ',T50,'  AREACL  ',T60,'  VARCEL  ')
      WRITE(6,8050)ICLSEC,ICLRA,OVRLAP,AREAP,AREACL,VARCEL
 8050 FORMAT(T5,I5,T13,I5,T23,F10.2,T38,3F10.2)
      VARSUM(ICLRA,ICLSEC)=VARSUM(ICLRA,ICLSEC)+VARCEL
  115 CONTINUE
  120 CONTINUE
      WRITE(6,8055)
 8055 FORMAT(2X,'SUMMARY OF EXTENSIVE VARIABLE:',                    '
     1CELL RADIUS(COLUMN) BY ',                                       'C
     2ELL SECTOR (ROW)')
      DO 125 ICLSEC=1,16
      WRITE(6,8060)(VARSUM(ICLRA,ICLSEC),ICLRA=1,5 )
 8060 FORMAT(2X,5F10.1)
  125 CONTINUE
      WRITE(6,8065)
 8065 FORMAT(2X,'END APORT EXECUTION')
      STOP
      END

      SUBROUTINE CELCOR(ICLSEC,ICLRA,RADIUS,XCL,YCL,NCL)
C       DETERMINES COORDINATES OF CELL BOUNDARIES
C
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C
C       D.E.FIELDS AND C.A.LITTLE
C       OCTOBER, 1977
```

```
C
      DIMENSION RADIUS(1),XCL(1),YCL(1)
      THETA1=1.374468+FLOAT(ICLSEC-1)*.3926991
      THETA2=1.767146+FLOAT(ICLSEC-1)*.3926991
      IF(ICLRA.NE.1)GOTO100
      NCL=3
      XCL(1)=0.0
      YCL(1)=0.0
      R=RADIUS(1)
      XCL(2)=R*COS(THETA1)
      YCL(2)=R*SIN(THETA1)
      XCL(3)=R*COS(THETA2)
      YCL(3)=R*SIN(THETA2)
      GOTO105
  100 CONTINUE
      NCL=4
      R1=RADIUS(ICLRA-1)
      R2=RADIUS(ICLRA)
      XCL(1)=R1*COS(THETA1)
      XCL(2)=R2*COS(THETA1)
      XCL(3)=R2*COS(THETA2)
      XCL(4)=R1*COS(THETA2)
      YCL(1)=R1*SIN(THETA1)
      YCL(2)=R2*SIN(THETA1)
      YCL(3)=R2*SIN(THETA2)
      YCL(4)=R1*SIN(THETA2)
  105 RETURN
      END

      SUBROUTINE CELCEN(ICLSEC,ICLRA,RADIUS,XCLCEN,YCLCEN)
C
C       DETERMINES COORDINATES OF CENTROID OF CELL IN POLAR SYSTEM
C
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C
C       D.E.FIELDS AND C.A.LITTLE
C       OCTOBER, 1977
C
      DIMENSION RADIUS(1)
      THETA=1.5708+FLOAT(ICLSEC-1)*.3926991
      R=RADIUS(1)/2.
      IF(ICLRA.NE.1)R=(RADIUS(ICLRA)+RADIUS(ICLRA-1))/2.
      YCLCEN=R*SIN(THETA)
      XCLCEN=R*COS(THETA)
      RETURN
      END

      SUBROUTINE PLYCOR(XP,YP,IV,SCALE,XPV,YPV,ASTART,
     1TART,XOFSET,YOFSET)
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C       PROVIDES POLYGON COORDINATES AND NUMBER OF VERTICES
C       D.E.FIELDS AND C.A.LITTLE
C
      DIMENSION XP(1),YP(1)
      IF(START.NE.ASTART)GOTO100
      XP(1)=XOFSET+XPV*SCALE
      YP(1)=YOFSET+YPV*SCALE
C       READ POLYGON COORDINATES
  100 READ(5,8000,END=110)IEND,START,XPV,YPV,IF,NP
 8000 FORMAT(I4,4X,A1,2F10.4,40X,I7,I3)
      IF(IEND.NE.9999)GOTO105
      WRITE(6,8005)
 8005 FORMAT(2X,'END OF POLYGON COORD SPECIFICATIONS')
```

```
      GOTO115
  105 CONTINUE
C       WRITE(6,30)START,XPV,YPV,IF,NP
 8010 FORMAT(9X,A1,2F10.4,40X,I7,I3)
      IF(START.EQ.ASTART.AND.IV.NE.100)RETURN
C       CONVERT POLYGON COORD TO MILES
      XP(NP)=XOFSET+XPV*SCALE
      YP(NP)=YOFSET+YPV*SCALE
      IV=NP
      GOTO100
  110 WRITE(6,8015)
 8015 FORMAT(2X,'PREMATURE END OF COORD DATA IN SUB. PLYCOR')
  115 RETURN
      END

      SUBROUTINE  PLYCEN(XP,YP,XPCEN,YPCEN,NP)
C       DETERMINES COORDINATES OF CENTROID OF POLYGON VERTICES
C
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C
C       D.E.FIELDS AND C.A.LITTLE
C       OCTOBER, 1977
C
      DIMENSION XP(1),YP(1)
      XPCEN=0.0
      YPCEN=0.0
      DO100 I=1,NP
      XPCEN=XPCEN+XP(I)
  100 YPCEN=YPCEN+YP(I)
      XPCEN=XPCEN/FLOAT(NP)
      YPCEN=YPCEN/FLOAT(NP)
      RETURN
      END


      LOGICAL FUNCTION SENSE(X,Y,N)
      COMMON AREA
C       SEE IUCALC DOCUMENTION
C       MODIFIED TO PROVIDE AREAS OF INTERSECTION POLYGONS
C
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C
C       D.E.FIELDS AND C.A.LITTLE
C       OCTOBER, 1977
C
      INTEGER N
      REAL X(N),Y(N)
      DOUBLE PRECISION TSUM
      IF(N.LT.3)RETURN
      TSUM=0.D0
      AY=Y(2)-Y(1)
      AX=X(2)-X(1)
      DO100 J=3,N
      BY=Y(J)-Y(1)
      BX=X(J)-X(1)
      TSUM=TSUM+BY*AX-AY*BX
      AX=BX
  100 AY=BY
      SENSE=.FALSE.
      IF(TSUM.LT.0.D0)SENSE=.TRUE.
      AREA=DABS(TSUM)/2.
C       WRITE(6,4)AREA
 8000 FORMAT(2X,'IN FNCT. SENSE, AREA =',F12.5)
```

```
      RETURN
      END

      LOGICAL FUNCTION FAR(XPCEN,YPCEN,XCLCEN,YCLCEN,FARAWY)
C       DETERMINES WHETHER POLYGON AND CELL ARE SUFFICIENTLY
C       CLOSE TO JUSTIFY FINDING UNION, ETC.
C
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APORT
C
C       D.E.FIELDS AND C.A.LITTLE
C       OCTOBER, 1977
C
      FAR=.FALSE.
      XD=XPCEN-XCLCEN
      YD=YPCEN-YCLCEN
C       DETERMINE DISTANCE BETWEEN CENTROIDS
      DIST=SQRT(XD*XD+YD*YD)
      IF(DIST.GT.FARAWY)FAR=.TRUE.
      RETURN
      END
```

APPENDIX C

LISTING OF CODE SUBSET

Code SUBSET is used in the preparation of the APORT data set (Chap. 3). It invokes the POLYVRT data manipulation package (Dutton 1974), assumed resident on the user's system. Thanks are due C. J. Emerson for his assistance in using the POLYVRT package.

```
//*NOSEQCARD
//DEFSUBS JOB (00000),'XCSD-FIELDS-B212'
/*ROUTE  PRINT LOCAL
//*CLASS CPU91=4M,SPECIAL=TAPE,IO=6
/*
//STP1 EXEC SPDASCR
//SYSIN DD *
 T.DEF16829.POLY
/*
//*      EXECUTE POLYVRT
//POLYVRT   EXEC   PGM=POLYVRT,REGION=270K
//STEPLIB   DD     DSN=ENVSCI.RJX12891.PVRTLGO,DISP=SHR,
//          UNIT=3330,VOL=SER=DISKAA
//GO.DUMP  DD  SYSOUT=A,DCB=(RECFM=FA,BLKSIZE=133)
//GO.FT53F001  DD  DSN=ENVSCI.RJX12891.PVRTLGO(POLYVRT),
//          DISP=(OLD,PASS),LABEL=(,,,IN),DCB=(RECFM=U,BLKSIZE=256)
//GO.FT06F001  DD  SYSOUT=A,DCB=(RECFM=FB,LRECL=137,BLKSIZE=2035)
//GO.FT07F001  DD  SYSOUT=B
//*     SCRATCH FILES FOR TEMP. STORAGE OF POINTS
//GO.FT19F001  DD  DSN=&&SCR1,UNIT=SYSDA,SPACE=(TRK,(90,10)),
//          DCB=(RECFM=VSB,LRECL=1344,BLKSIZE=4036),DISP=(NEW,DELETE)
//GO.FT20F001  DD  DSN=&&SCR2,UNIT=SYSDA,SPACE=(TRK,(90,10)),
//          DCB=*.FT19F001,SEP=FT19F001,DISP=(NEW,DELETE)
//*     INPUT POLYVRT GEOGRAPHIC BASE FILE, DISK OR TAPE
//GO.FT35F001 DD UNIT=TAPE9,VOL=SER=X14554,
```

```
// LABEL=(3,NL),DISP=(OLD,KEEP),
// DCB=(RECFM=FB,LRECL=54,BLKSIZE=8100)
//*     OUTPUT FILE (CARD IMAGES)
//GO.FT37F001 DD DSN=T.DEF16829.POLY,DISP=(NEW,CATLG),
// UNIT=SPDA,SPACE=(TRK,(20,5),RLSE),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//*     CALCOMP PLOT TAPE
//GO.PLOTTAPE  DD  DUMMY
//GO.FT05F001 DD *
A-INPUT    DIMECO
B-SELECT   INCLUDE
IF         STATE       EQ          34  AND COUNTY     EQ           1
OR         STATE       EQ          34  AND COUNTY     EQ           5
OR         STATE       EQ          34  AND COUNTY     EQ           7
OR         STATE       EQ          34  AND COUNTY     EQ          11
OR         STATE       EQ          34  AND COUNTY     EQ          15
IF         STATE       EQ          34  AND COUNTY     EQ          21
OR         STATE       EQ          34  AND COUNTY     EQ          23
OR         STATE       EQ          34  AND COUNTY     EQ          25
OR         STATE       EQ          34  AND COUNTY     EQ          29
IF         STATE       EQ          34  AND COUNTY     EQ          33
OR         STATE       EQ          34  AND COUNTY     EQ          35
OR         STATE       EQ          36  AND COUNTY     EQ          85
OR         STATE       EQ          42  AND COUNTY     EQ          17
OR         STATE       EQ          42  AND COUNTY     EQ          91
END
C-READ
END
E-MANIPULATE
PROJECT    C-LAMBERT
           MERIDEAN  -75.
           PARALLELS 39.       41.
           FRACTION  600000.
           ORIGIN    39.8100   -74.21000
END
F-GENERAL            10.
G-OUTPUT   SYMAP     1.        0.                        1.
END
Z-FINISH
/*
//
```

APPENDIX D

SAMPLE APORT INPUT DATA SET

The construction of this sample data set is described in Chap. 3. When used as input to the APORT code, the output given in Appendix E is produced. The same data set may be used as input to code APOPLT, described in Chap. 6. The corresponding APOPLT graphical output, also described in Chap. 6, is shown in Fig. 3.

```
74.205167 39.8145   600000.      14
74.187500 39.8
 1  131
 513078
 7  125
11 3760
15 3816
21 3754
23 2753
25 4028
29  349
3317125
35 7198
85    0
1718834
9115122
  0    A   -2.7985  -0.5542                                34001  1
  0        -3.8290  -1.6182                                34001  2
  0        -4.3379  -2.1787                                34001  3
  0        -3.6244  -2.7925                                34001  4
  0        -3.6068  -3.5491                                34001  5
  0        -2.0532  -3.8828                                34001  6
  0        -1.0247  -2.8359                                34001  7
  0        -0.9075  -2.5552                                34001  8
  0        -1.0050  -1.9749                                34001  9
  0        -1.1342  -1.9211                                34001 10
  0        -1.7215  -1.7661                                34001 11
  0        -2.4679  -1.2971                                34001 12
  0        -2.7985  -0.5542                                34001 13
  0    A   -2.0408   2.2827                                34005  1
  0        -2.7614   2.7439                                34005  2
  0        -2.9588   2.5508                                34005  3
  0        -2.9393   2.4465                                34005  4
  0        -4.2553   1.7544                                34005  5
  0        -4.7004   1.3494                                34005  6
  0        -3.9695   0.4924                                34005  7
  0        -3.8148  -0.1553                                34005  8
  0        -3.3844  -0.1921                                34005  9
  0        -2.7985  -0.5542                                34005 10
  0        -2.4679  -1.2971                                34005 11
  0        -1.7215  -1.7661                                34005 12
  0        -1.1342  -1.9211                                34005 13
```

0		-0.9419	-0.3567	34005	14
0		-1.8662	1.9241	34005	15
0		-2.0408	2.2827	34005	16
0	A	-2.7985	-0.5542	34007	1
0		-3.3844	-0.1921	34007	2
0		-3.8148	-0.1553	34007	3
0		-3.9695	0.4924	34007	4
0		-4.7004	1.3494	34007	5
0		-5.0626	1.0527	34007	6
0		-5.2621	0.5347	34007	7
0		-4.9064	0.2332	34007	8
0		-4.4538	-0.6699	34007	9
0		-4.0004	-0.9246	34007	10
0		-3.8290	-1.6182	34007	11
0		-2.7985	-0.5542	34007	12
0	A	-4.8310	-1.9736	34011	1
0		-4.8737	-2.6174	34011	2
0		-5.7591	-1.8843	34011	3
0		-6.2669	-2.3887	34011	4
0		-6.7357	-2.5789	34011	5
0		-6.8084	-2.9670	34011	6
0		-6.1169	-3.8020	34011	7
0		-5.7967	-3.8279	34011	8
0		-5.3963	-4.1968	34011	9
0		-5.1249	-4.6321	34011	10
0		-4.8039	-4.4065	34011	11
0		-3.9681	-4.7283	34011	12
0		-4.0040	-4.3147	34011	13
0		-3.6068	-3.5491	34011	14
0		-3.6244	-2.7925	34011	15
0		-4.3379	-2.1787	34011	16
0		-4.7151	-1.8440	34011	17
0		-4.8310	-1.9736	34011	18
0	A	-3.8290	-1.6182	34015	1
0		-4.3379	-2.1787	34015	2
0		-4.7151	-1.8440	34015	3
0		-4.8310	-1.9736	34015	4
0		-4.8019	-1.7271	34015	5
0		-5.5545	-1.0906	34015	6
0		-6.4569	-0.6868	34015	7
0		-6.6608	-0.2634	34015	8
0		-6.8917	-0.2000	34015	9
0		-6.3087	0.2324	34015	10
0		-5.2621	0.5347	34015	11
0		-4.9064	0.2332	34015	12
0		-4.4538	-0.6699	34015	13
0		-4.0004	-0.9246	34015	14
0		-3.8290	-1.6182	34015	15
0	A	-3.0504	4.4983	34021	1
0		-3.3240	4.4727	34021	2
0		-3.3265	4.2092	34021	3
0		-3.7214	4.1543	34021	4
0		-3.6859	3.9370	34021	5
0		-3.9661	3.8154	34021	6
0		-2.9588	2.5508	34021	7
0		-2.7614	2.7439	34021	8
0		-2.0408	2.2827	34021	9
0		-2.1673	2.6709	34021	10
0		-1.3921	3.3562	34021	11
0		-2.3476	3.8403	34021	12
0		-2.3842	4.1831	34021	13
0		-2.8905	4.1980	34021	14
0		-3.0504	4.4983	34021	15

0	A	-0.4255	4.9058	34023	1
0		-0.4944	5.1726	34023	2
0		-0.1092	5.8279	34023	3
0		-1.5559	5.7507	34023	4
0		-1.8786	5.5688	34023	5
0		-1.4823	5.1196	34023	6
0		-1.5545	4.9814	34023	7
0		-2.3842	4.1831	34023	8
0		-2.3476	3.8403	34023	9
0		-1.3921	3.3562	34023	10
0		-1.0451	3.4507	34023	11
0		-0.2997	4.3215	34023	12
0		-0.2799	4.6101	34023	13
0		-0.0771	4.6912	34023	14
0		-0.4255	4.9058	34023	15
0	A	-1.3921	3.3562	34025	1
0		-2.1673	2.6709	34025	2
0		-2.0408	2.2827	34025	3
0		-1.8662	1.9241	34025	4
0		-1.1929	2.6597	34025	5
0		-0.3210	2.6367	34025	6
0		-0.2994	2.3528	34025	7
0		-0.0775	2.2083	34025	8
0		0.2905	2.1404	34025	9
0		0.5471	2.3938	34025	10
0		0.7325	2.0906	34025	11
0		1.0958	2.1907	34025	12
0		1.3668	3.3474	34025	13
0		1.2796	4.5544	34025	14
0		1.0636	4.7944	34025	15
0		1.0684	4.3599	34025	16
0		0.5921	4.5764	34025	17
0		0.0706	4.5337	34025	18
0		-0.0771	4.6912	34025	19
0		-0.2799	4.6101	34025	20
0		-0.2997	4.3215	34025	21
0		-1.0451	3.4507	34025	22
0		-1.3921	3.3562	34025	23
0	A	-1.1342	-1.9211	34029	1
0		-0.9419	-0.3567	34029	2
0		-1.8662	1.9241	34029	3
0		-1.1929	2.6597	34029	4
0		-0.3210	2.6367	34029	5
0		-0.2994	2.3528	34029	6
0		-0.0775	2.2083	34029	7
0		0.2905	2.1404	34029	8
0		0.5471	2.3938	34029	9
0		0.7325	2.0906	34029	10
0		1.0958	2.1907	34029	11
0		0.7781	-0.1411	34029	12
0		0.6109	-0.1179	34029	13
0		0.7714	1.1169	34029	14
0		0.6475	1.6340	34029	15
0		0.4523	0.3071	34029	16
0		0.2125	-0.1299	34029	17
0		0.2024	-0.7571	34029	18
0		-0.5264	-1.7288	34029	19
0		-0.5918	-2.0220	34029	20
0		-1.0050	-1.9749	34029	21
0		-1.1342	-1.9211	34029	22
0	A	-4.8310	-1.9736	34033	1
0		-4.8737	-2.6174	34033	2
0		-5.7591	-1.8843	34033	3

0		-6.2669	-2.3887	34033	4
0		-6.7357	-2.5789	34033	5
0		-6.8084	-2.9670	34033	6
0		-7.3220	-2.4084	34033	7
0		-7.2601	-1.7527	34033	8
0		-7.5132	-1.4878	34033	9
0		-7.3846	-0.9663	34033	10
0		-6.8917	-0.2000	34033	11
0		-6.6608	-0.2634	34033	12
0		-6.4569	-0.6868	34033	13
0		-5.5545	-1.0906	34033	14
0		-4.8019	-1.7271	34033	15
0		-4.8310	-1.9736	34033	16
0	A	-1.5559	5.7507	34035	1
0		-1.2035	6.2461	34035	2
0		-1.4127	6.1943	34035	3
0		-1.4831	6.3359	34035	4
0		-1.8341	6.1460	34035	5
0		-1.7764	6.6104	34035	6
0		-1.9834	6.8767	34035	7
0		-2.9235	6.6599	34035	8
0		-2.8600	5.6150	34035	9
0		-3.2907	5.1333	34035	10
0		-3.0504	4.4983	34035	11
0		-2.8905	4.1980	34035	12
0		-2.3842	4.1831	34035	13
0		-1.5545	4.9814	34035	14
0		-1.4823	5.1196	34035	15
0		-1.8786	5.5688	34035	16
0		-1.5559	5.7507	34035	17
0	A	-0.4255	4.9058	36085	1
0		0.0779	5.1316	36085	2
0		0.7857	5.8323	36085	3
0		0.5658	6.2439	36085	4
0		0.1166	6.1309	36085	5
0		-0.1092	5.8279	36085	6
0		-0.4944	5.1726	36085	7
0		-0.4255	4.9058	36085	8
0	A	-4.2553	1.7544	42017	1
0		-4.1756	2.1726	42017	2
0		-4.4953	2.3938	42017	3
0		-7.0914	4.4788	42017	4
0		-6.6113	5.0991	42017	5
0		-5.5800	5.8523	42017	6
0		-5.3902	5.5632	42017	7
0		-4.8916	5.5083	42017	8
0		-4.7811	4.6052	42017	9
0		-4.2468	4.3379	42017	10
0		-3.9661	3.8154	42017	11
0		-2.9588	2.5508	42017	12
0		-2.9393	2.4465	42017	13
0		-4.2553	1.7544	42017	14
0	A	-4.4953	2.3938	42091	1
0		-5.0297	1.7717	42091	2
0		-5.7456	2.0657	42091	3
0		-5.9028	1.8027	42091	4
0		-5.6124	1.5176	42091	5
0		-5.9302	1.2261	42091	6
0		-6.4941	1.9470	42091	7
0		-6.9511	2.0452	42091	8
0		-6.9846	2.3462	42091	9
0		-7.3541	2.5366	42091	10
0		-7.7465	3.1243	42091	11

0	-8.2980	3.1907	42091 12
0	-7.3957	4.6978	42091 13
0	-7.0914	4.4788	42091 14
0	-4.4953	2.3938	42091 15
9999	0.0	0.0	0 0

APPENDIX E

APORT OUTPUT CORRESPONDING TO APPENDIX D

```
  74.2052    39.8145 600000.00    14
  74.1875    39.8000
 1  131
 513078
 7  125
11 3760
15 3816
21 3754
23 2753
25 4028
29  349
3317125
35 7198
85    0
1718834
9115122
XOFSET.YOFSET.ALAT=          -0.937092        1.002659         0.694707
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5          3            1.18          563.47      95.67        0.27
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      6          3           34.49          563.47      95.67        8.02
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      6          4          100.25          563.47     133.93       23.31
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      6          5           45.92          563.47     172.20       10.68
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      7          3           71.14          563.47      95.67       16.54
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      7          4          133.93          563.47     133.93       31.14
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      7          5           90.17          563.47     172.20       20.96
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      8          3           38.11          563.47      95.67        8.86
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      8          4           42.34          563.47     133.93        9.84
POLYGON INTERSECTION. J=     1 AND IPOL =     1; NFIPS =    1
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      8          5            5.92          563.47     172.20        1.38
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3          2            1.39          822.92      57.40       22.11
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3          3           42.55          822.92      95.67      676.18
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3          4           66.28          822.92     133.93     1053.29
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4          2           35.57          822.92      57.40      565.29
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4          3           95.67          822.92      95.67     1520.33
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4          4          133.82          822.92     133.93     2126.63
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4          5           69.85          822.92     172.20     1110.08
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5          2           53.10          822.92      57.40      843.85
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5          3           91.35          822.92      95.67     1451.72
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5          4           68.32          822.92     133.93     1085.78
POLYGON INTERSECTION. J=     1 AND IPOL =     2; NFIPS =    5
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5          5            0.88          822.92     172.20       14.03
```

```
POLYGON INTERSECTION, J=     1 AND IPOL =    2; NFIPS =    5
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           2           52.52         822.92      57.40      354.04
POLYGON INTERSECTION, J=     1 AND IPOL =    2; NFIPS =    5
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           3           61.09         822.92      95.67      970.88
POLYGON INTERSECTION, J=     1 AND IPOL =    2; NFIPS =    5
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    7           2           26.28         822.92      57.40      417.05
POLYGON INTERSECTION, J=     1 AND IPOL =    2; NFIPS =    5
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    7           3           24.22         822.92      95.67      384.87
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    4           5           21.63         238.55     172.20       11.34
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    5           3            3.14         238.55      95.67        1.04
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    5           4           65.56         238.55     133.93       34.35
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    5           5          108.34         238.55     172.20       56.77
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           3            0.09         238.55      95.67        0.05
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           4           33.13         238.55     133.93       17.36
POLYGON INTERSECTION, J=     1 AND IPOL =    3; NFIPS =    7
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           5            1.16         238.55     172.20        0.01
POLYGON INTERSECTION, J=     1 AND IPOL =    4; NFIPS =   11
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           5           38.96         509.63     172.20      287.45
POLYGON INTERSECTION, J=     1 AND IPOL =    4; NFIPS =   11
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    7           5           32.49         509.63     172.20      239.67
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    3           4            0.05         338.44     133.93        0.59
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    5           5           62.98         338.44     172.20      710.13
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           4            0.56         338.44     133.93        0.26
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    6           5           97.64         338.44     172.20     1100.95
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    7           3           36.12         488.34      95.67      282.25
POLYGON INTERSECTION, J=     1 AND IPOL =    5; NFIPS =   15
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    7           4            5.20         488.34     133.93       40.05
POLYGON INTERSECTION, J=     1 AND IPOL =    6; NFIPS =   21
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    2           4           26.24         239.53     133.93      411.31
POLYGON INTERSECTION, J=     1 AND IPOL =    6; NFIPS =   21
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    2           5           21.58         239.53     172.20      338.20
POLYGON INTERSECTION, J=     1 AND IPOL =    6; NFIPS =   21
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    3           4           45.02         239.53     133.93      705.62
POLYGON INTERSECTION, J=     1 AND IPOL =    6; NFIPS =   21
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    3           5          105.37         239.53     172.20     1651.38
POLYGON INTERSECTION, J=     1 AND IPOL =    7; NFIPS =   23
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    1           4            1.41         309.96     133.93       12.48
POLYGON INTERSECTION, J=     1 AND IPOL =    7; NFIPS =   23
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    1           5           45.83         309.96     172.20      407.09
POLYGON INTERSECTION, J=     1 AND IPOL =    7; NFIPS =   23
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    2           4           31.20         309.96     133.93      277.13
POLYGON INTERSECTION, J=     1 AND IPOL =    7; NFIPS =   23
  SECTOR      RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
    2           5          136.50         309.96     172.20     1212.36
```

```
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           3          84.74           497.17      95.67      680.53
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
POLYGON INTERSECTION, J=    2 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           4          82.82           336.40     133.93      991.72
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
POLYGON INTERSECTION, J=    2 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           5          61.91           336.40     172.20      741.27
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      2           3          18.30           336.40      95.67      219.16
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
POLYGON INTERSECTION, J=    2 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      2           4          16.19           336.40     133.93      193.89
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3           3          12.00           336.40      95.67      143.71
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3           4          13.54           336.40     133.93      102.11
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
POLYGON INTERSECTION, J=    2 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
     15           4         841.14           336.40     133.93    10071.70
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
     16           3          55.68           584.19      95.67      383.90
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
     16           4         128.29           584.19     133.93      884.52
POLYGON INTERSECTION, J=    1 AND IPOL =    8; NFIPS =  25
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
     16           5         106.44           584.19     172.20      733.88
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           1          19.13           677.00      19.13        9.86
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           2          57.40           677.00      57.40       29.59
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      1           3          25.92           677.00      95.67       13.36
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      2           1          19.13           437.24      19.13       15.27
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      2           2          57.40           437.24      57.40       45.82
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      2           3          74.98           437.24      95.67       59.85
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3           1          19.13           437.24      19.13       15.27
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3           2          56.01           437.24      57.40       44.71
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      3           3          41.12           437.24      95.67       32.82
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4           1          19.13           437.24      19.13       15.27
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      4           2          21.83           437.24      57.40       17.42
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5           1          19.13           437.24      19.13       15.27
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      5           2           4.30           437.24      57.40        3.43
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      6           1          15.15           437.24      19.13       12.09
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
   SECTOR      RADIUS     AREAL OVERLAP      AREAP      AREACL      VARCEL
      6           2           0.11           437.24      57.40        0.08
```

```
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     7          1          9.51         437.24     19.13        7.59
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     8          1          8.58         437.24     19.13        6.85
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     8          2        121.92         437.24     57.40       97.31
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     8          3        114.30         196.15     95.67      203.36
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     9          1        262.54          67.05     19.13     1366.58
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     9          2        206.23         271.04     57.40      265.55
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    10          1          1.76         333.89     19.13        1.83
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    11          1          0.42         333.89     19.13        0.44
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    12          1          0.24         333.89     19.13        0.25
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    13          1          0.20         333.89     19.13        0.21
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    14          1          0.24         333.89     19.13        0.25
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    15          1          0.42         333.89     19.13        0.44
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    15          3        504.80         333.89     95.67      327.65
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
POLYGON INTERSECTION, J=    2 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    16          1        726.16         186.27     19.13     1360.56
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    16          2         30.86         725.48     57.40       14.85
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    16          3         81.31         725.48     95.67       39.11
POLYGON INTERSECTION, J=    1 AND IPOL =    9; NFIPS =  29
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
    16          4          1.91         725.48    133.93        0.92
POLYGON INTERSECTION, J=    1 AND IPOL =   10; NFIPS =  33
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     6          5          0.15         340.72    172.20        7.73
POLYGON INTERSECTION, J=    1 AND IPOL =   11; NFIPS =  35
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     2          5         14.12         294.63    172.20      344.95
POLYGON INTERSECTION, J=    1 AND IPOL =   11; NFIPS =  35
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     3          5          0.55         294.63    172.20       13.35
POLYGON INTERSECTION, J=    1 AND IPOL =   12; NFIPS =  85
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     1          5          3.11          73.74    172.20        0.0
POLYGON INTERSECTION, J=    1 AND IPOL =   13; NFIPS =  17
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     3          4          5.78         616.82    133.93      176.43
POLYGON INTERSECTION, J=    1 AND IPOL =   13; NFIPS =  17
  SECTOR     RADIUS    AREAL OVERLAP    AREAP     AREACL      VARCEL
     3          5         66.28         616.82    172.20     2023.93
```

```
 POLYGON INTERSECTION, J=     1 AND IPOL =    13; NFIPS =   17
   SECTOR     RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
      4         4          0.12           616.82     133.93       3.54
 POLYGON INTERSECTION, J=     1 AND IPOL =    13; NFIPS =   17
   SECTOR     RADIUS     AREAL OVERLAP     AREAP      AREACL     VARCEL
      4         5         46.14           616.82     172.20    1408.80
 END OF POLYGON COORD SPECIFICATIONS
 SUMMARY OF EXTENSIVE VARIABLE; CELL RADIUS(COLUMN) BY CELL SECTOR (ROW)
        9.9        29.6       699.9      1004.2      1148.4
       15.3        45.8       279.0       882.3      1895.5
       15.3        66.8       852.7      2097.4      3688.7
       15.3       582.7      1520.3      2130.2      2530.2
       15.3       847.3      1453.6      1120.7       780.9
       12.1       834.7       978.9        46.9      1407.4
        7.6       417.7       683.7        71.8       260.6
        6.8        97.3       212.2         9.8         1.4
     1366.6       265.6         0.0         0.0         0.0
        1.8         0.0         0.0         0.0         0.0
        0.4         0.0         0.0         0.0         0.0
        0.2         0.0         0.0         0.0         0.0
        0.2         0.0         0.0         0.0         0.0
        0.2         0.0         0.0         0.0         0.0
        0.4         0.0       527.7     10071.7         0.0
     1360.6        14.8       423.0       885.4       733.9
 END APORT EXECUTION

IHC002I STOP       0
```

APPENDIX F

JOB CONTROL LANGUAGE FOR APOPLT PLOTTER CODE

Note links to the DISSPLA* package referenced in Chap. 6. DISSPLA is assumed resident on the user's computer system.

---

*Proprietary software product of Integrated Software Systems Corp., San Diego, California.

```
//DEFAPOP JOB (00000),'XCSD-FIELDS-B212',MSGLEVEL=(2,0)
/*ROUTE PRINT LOCAL
/*ROUTE PUNCH LOCAL
//*CLASS CPU91=20S,IO=2,R=270,LINES=5,CARDS=0
// EXEC FORTHCLG,PARM.FORT='XREF',PARM.GO='EU=-1,DUMP=I',
// REGION.GO=250K
//FORT.SYSIN DD *
=APOPLT
/*
//LKED.SYSLIB   DD
//              DD
//              DD
//              DD  DSN=SYS2.DISSPLA,DISP=SHR
//LKED.PLOTSUBS DD DSN=JGSPLOTH,DISP=SHR
//LKED.SYSIN    DD *         HEX DECK FOLLOWS
  INCLUDE PLOTSUBS
/*
//GO.FT49F001 DD UNIT=IN2OU2,DISP=(NEW,KEEP),
// SPACE=(3208,99,RLSE),
// DCB=(RECFM=VS,LRECL=3204,BLKSIZE=3208),
// DSN=PLOT00.DEFQ
//GO.SYSUDMP DD SYSOUT=A
//GO.FT05F001 DD *
=APORT.DAT


/*
//
```

APPENDIX G

FORTRAN IV SOURCE LISTING OF APOPLT PLOTTER CODE

```
C        MAIN PROGRAM APOPLT
C        AUTOMATED REGIONAL METHODOLOGY CODE
C
C        PLOTS CONCENTRIC GRID AND POLYGONS USED BY APORT CODE
C
C        REQUIRES DATA SET APORT.DAT
C
C
C        D.E.FIELDS AND C.A.LITTLE
C        FEB. 1978
C
      DIMENSION RADIUS(5),NFIPS(50),XP(361),YP(361),VARP(50),IM(2)
      DATA START/999./,ASTART/'A'/,NP/100/
C        READ ORIGIN OF SYMAP COORDINATE SYSTEM
C         IN DEGREES LON AND LAT
C        READ SCALE FACTOR, INCHES TO INCHES:    SCALE
      READ(5,8000)XORPLY,YORPLY,SCALE,NPOLY
 8000 FORMAT(1X,3F10.2,I5)
      WRITE(6,8000)XORPLY,YORPLY,SCALE,NPOLY
      SCALE=SCALE/5280./12.
      IF(NPOLY.GT.50)WRITE(6,8005)
 8005 FORMAT(2X,'NUMBER OF POLYGONS SPECIFIED EXCEEDS LIMIT OF 50')
C        READ ORIGIN OF POLAR COORDINATE SYSTEM
C         IN DEGREES LON AND LAT
      READ(5,8010)XORCEL,YORCEL
 8010 FORMAT(1X,2F10.4)
C        READ VALUE OF EXTENSIVE VARIABLE FOR EACH POLYGON
      READ(5,8015)(NFIPS(I),VARP(I),I=1,NPOLY)
 8015 FORMAT(1X,I2,I5)
C        WRITE(6,5)(NFIPS(I),VARP(I),I=1,NPOLY)
C        COMPUTE OFFSET, IN MILES, OF POLYGON IN POLAR SYSTEM
      ALAT=(YORPLY+YORCEL)/360.*3.141593
      XOFSET=(-XORPLY+XORCEL)*60.*1.1516*COS(ALAT)
      YOFSET=(YORPLY-YORCEL)*60.*1.1516
C        TEMPORARY***********
      WRITE(6,8020)XOFSET,YOFSET,ALAT
 8020 FORMAT(2X,'XOFSET,YOFSET,ALAT=',3F15.6)
C        RADIAL DISTANCES IN MILES
      DO 100 I=1,5
  100 RADIUS(I)=10.*FLOAT(I)
C
C        BEGIN PLOT OF POLYGONS
C        CALL TKTRN(120)
      CALL CALCMP
      CALL BGNPL(1)
      CALL PAGE(11.0,11.0)
C        CALL HEADIN('OYSTER CREEK$',100,1.,2)
C
C        1 PLOTTER INCH = 20 MILES
      FACT = 20.
      ORI=-4.*FACT
      CALL CROSS
      CALL TITLE(23HAPORT POLYGON STRUCTURE,23,' ',1,' ',1,8.,8.)
      CALL GRAPH(ORI,FACT,ORI,FACT)
C        BEGIN POLYGON LOOP
C        ******TEMPORARY
      DO 110 IPLY=1,NPOLY
      CALL PLT1(XP,YP,NP,SCALE,XPV,YPV,ASTART,START,XOFSET,YOFSET)
```

```
      NPM1=NP-1
      CALL CURVE(XP,YP,NP,0)
C       COMPUTE CENTROID
      XC=0.0
      YC=0.0
      DO 105 I=1,NPM1
      XC=XC+XP(I)
      YC=YC+YP(I)
  105 CONTINUE
      PN=FLOAT(NPM1)
      XC=(XC/PN)
      YC=(YC/PN)
C
C       IDENTIFY POLYGONS BY COUNTY FIPS CODE
      CALL RLINT(NFIPS(IPLY),XC,YC)
  110 CONTINUE
C       END POLYGON LOOP
C
C       BEGIN POLAR GRID PLOT
      PI180=3.14159/180.
C
      DO 120 IR=1,5
      R=RADIUS(IR)
      XP(1)=R
      YP(1)=0.
      DO115 I=1,360
      ANG=FLOAT(I)*PI180
      XP(I+1)=R*COS(ANG)
      YP(I+1)=R*SIN(ANG)
  115 CONTINUE
      CALL CURVE(XP,YP,361,0)
  120 CONTINUE
C       CONSTRUCT SCALE BARS
      CALL STRTPT(7.5,2.6)
      CALL CONNPT(7.5,2.4)
      CALL STRTPT(7.5,2.5)
      CALL CONNPT(8.5,2.5)
      CALL STRTPT(8.5,2.6)
      CALL CONNPT(8.5,2.4)
      CALL REALNO(FACT,1,7.7,2.6)
      CALL LINES('MILES$',IM,1)
      CALL STORY(IM,1,7.75,2.28)
      CALL ENDPL(1)
      CALL DONEPL
      STOP
      END
      SUBROUTINE PLT1(XP,YP,IV,SCALE,XPV,YPV,ASTART,
     1TART,XOFSET,YOFSET)
C       AUTOMATED REGIONAL METHODOLOGY CODE
C       CALLED BY MAIN PROGRAM APOPLT
C       PROVIDES POLYGON COORDINATES AND NUMBER OF VERTICES
C       D.E.FIELDS AND C.A.LITTLE
C
      DIMENSION XP(1),YP(1)
      IF(START.NE.ASTART)GOTO100
      XP(1)=(XOFSET+XPV*SCALE)
      YP(1)=(YOFSET+YPV*SCALE)
C       READ POLYGON COORDINATES
  100 READ(5,8000,END=110)IEND,START,XPV,YPV,IF,NP
 8000 FORMAT(I4,4X,A1,2F10.4,40X,I7,I3)
      IF(IEND.NE.9999)GOTO105
      WRITE(6,8005)
 8005 FORMAT(2X,'END OF POLYGON COORD IN SUB PLT1')
```

```
      GOTO115
  105 CONTINUE
C27      WRITE(6,30)START,XPV,YPV,IF,NP
 8010 FORMAT(9X,A1,2F10.4,40X,I7,I3)
C        CONVERT POLYGON COORD TO MILES
      IF(START.EQ.ASTART.AND.IV.NE.100)RETURN
      IV=NP
      XP(IV)=(XOFSET+XPV*SCALE)
      YP(IV)=(YOFSET+YPV*SCALE)
      GOTO100
  110 WRITE(6,8015)
 8015 FORMAT(2X,'PREMATURE END OF COORD DATA IN SUB. PLT1')
  115 RETURN
      END
```

U.S. GOVERNMENT PRINTING OFFICE: 1977-748-189/272

ORNL/TM-6418
Distribution
Category UC-11, UC-41

INTERNAL DISTRIBUTION

1. A. A. Brooks
2. H. P. Carter
3. R. O. Chester
4. P. R. Coleman
5. S. J. Cotter
6. J. S. Crowell
7. R. M. Davis
8. H. W. Dickson
9. D. E. Dunning, Jr.
10. R. C. Durfee
11. R. G. Edwards
12. C. J. Emerson
13. E. L. Etnier
14-23. D. E. Fields
24. R. G. Funderlic
25. W. R. Garrett
26. F. F. Haywood
27. R. F. Hibbs
28. G. S. Hill
29. R. B. Honea
30. F. O. Hoffman
31. S. V. Kaye
32. G. G. Killough
33. D. C. Kocher
34-43. C. A. Little
44. A. Loebl
45. E. C. Long
46. L. M. McDowell-Boyer
47. H. R. Meyer
48. C. W. Miller
49. R. E. Moore
50. B. D. Murphy
51. F. R. O'Donnell
52. R. J. Olson
53-56. D. C. Parzyck
57. J. K. Poggenburg
58. H. Postma
59. R. J. Raridon
60. M. L. Randolph
61. C. R. Richmond
62-65. P. S. Rohwer
66. E. M. Rupp
67. D. L. Shaeffer
68. R. W. Shor
69. C. C. Travis
70. P. J. Walsh
71. A. P. Watson
72-75. J. P. Witherspoon
76. H. A. Wright
77. M. G. Yalcintas
78. Central Research Lib.
79. ORNL Y-12 Library, Document Ref. Section
80-81. Laboratory Rec. Dept.
82. Laboratory Records, ORNL-RC
83. ORNL Patent Office

EXTERNAL DISTRIBUTION

84. Director, Research and Technical Support Division, DOE-ORO.
85. J. P. Corley, Battelle Northwest Laboratory, P. O. Box 999, Richland, WA 99352.
86. J. N. Rogers, Division 8324, Sandia Laboratories, Livermore, CA 94550.
87. Chief, Mathematics and Geoscience Branch, Department of Energy, Washington, D. C. 20545.
88. J. K. Soldat, Battelle Northwest Laboratory, P. O. Box 999, Richland, WA 99352.
89. F. G. Goff, 1357 S. Dam Rd., West Branch, Michigan 48661.
90-406. Given distribution as shown in TID-4500 under Distribution Category UC-11 and UC-41.